Royal Institution in 1854: "I am not bound to explain how a table tilts any more than to indicate how, under the conjurer's hands, a pudding appears in a hat." Baron von Schrenck-Notzing and Dr. Fournier d'Albe have a clear course before them. Let them bring "Eva C." to London to exhibit her "materialisations" before a committee of which Sir Ray Lankester, Sir Bryan Donkin, and Mr. Nevil Maskelyne should be members. Then the matter would be put beyond doubt whether the so-called evidence, thus judicially sifted, is or is not based upon the collusive action of mediums and upon the bad, because prejudiced, observation of the sitters. The need to keep in mind what Hume says about occult phenomena was never more urgent than it is to-day. "As finite added to finite never approaches a hair's breadth nearer to infinite, so a fact [statement?] incredible in itself acquires not the smallest accession of probability by the accumulation of testimony."

Boltzmann's Lectures.

Ludwig Boltzmanns Vorlesungen über die Prinzipe der Mechanik. Dritter Teil. Elastizitätstheorie und Hydromechanik. Edited by Prof. Hugo Buchholz. Pp. xiii+608–820. (Leipzig: Johann Ambrosius Barth, 1920.) Price 21.60 marks.

THE name of Ludwig Boltzmann will live on account of his great creative work, the study of which has happily been facilitated by the publication of his collected "Wissenschaftliche Abhandlungen" (3 vols., 1909, Barth), through the co-operation of the Academies of Berlin, Göttingen, Leipzig, Munich, and Vienna. But he was distinguished also as a teacher, and his power of exposition is shown in several volumes of lectures which have appeared in print. Perhaps the best of these are his "Vorlesungen über Gastheorie" (2 vols., 1895), based chiefly on Maxwell's and his own fundamental researches on the subject. Less well known are his lectures on Maxwell's theory of electricity and light, and those on the principles of mechanics, each occupying two volumes.

The book now under review comes from the same Leipzig press, and forms a third and final volume of the lectures on mechanics. Unlike the preceding volumes, it does not come direct from Boltzmann himself; it is written, on the basis of his lectures, by one of his pupils, Buchholz, to whom Boltzmann, and afterwards his widow, allotted the work of editorship. It first appeared in 1916 as an appendix to a larger volume of Boltzmann's lectures, also edited by Buchholz, entitled "Applied Mathematics: the Mechanical Potential and its Application to the Determination of the Figure of the Earth (Higher Geodesy)." It contains the theory of elasticity and hydrodynamics which was a necessary adjunct to the geodetic part of that treatise; but its separate publication as a third volume of the principles of mechanics fulfils Boltzmann's intentions regarding the latter course of lectures, and renders it readily available to those who do not wish to study the larger work from which it is reprinted.

Boltzmann's lectures on mathematical physics formed a "cycle" unified by his use of the conception of the potential—the mechanical, electrical, and electrodynamic potentials, as in the lectures previously published, and, in the present volume, the elastic and hydrodynamic potentials. One further set of lectures remains unpublished—namely, that on the general mechanical theory of heat; in this course the thermodynamic potential is introduced and illustrated by three important examples of its application, of which Gibbs's theory of chemical equilibrium is the chief. This final instalment is at present held up owing to financial difficulties; it is much to be hoped that these may be overcome, in order to complete Boltzmann's representation of mathematical physics and in view especially of the close relation of these lectures to his work on gas theory.

Although beyond a certain point the theories of elasticity and hydrodynamics diverge widely, their kinematical foundations are almost identical, while the theory of the stress ellipsoid is as necessary to hydrodynamics as it is to elasticity when the viscosity of liquids is taken into account (though in the present volume the latter is not done). It is therefore illuminating to consider the two subjects together, and their treatment in these lectures is admirable. The explanations of the kinematical and mechanical principles are simple and detailed, and the elastic potential is then introduced and applied to a few important general problems—in particular, to the proof of the Hamiltonian principle for elastic potential energy, to the determination of the potential for various forms of crystal, and to the propagation of waves of compression and distortion in an elastic solid. This is all done in comparatively little compass—a hundred pages—and a general grasp of the subject is rendered easy by the avoidance of individual problems, such as the theory of bending in beams, or the vibrations of rods, strings, and membranes, in which the potential plays no prominent part.

The second hundred pages are devoted, on similar lines, to the general equations of hydrodynamics, the velocity potential, and the theory

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of wave-motion and vortex-motion. Both water- and sound-waves are discussed, including the change of form of progressive waves on water. The analogies with other branches of science are pointed out from time to time, such as, for example, that between the magnetic field of an electric current and the irrotational motion round a vortex filament. The book should be valuable both to readers approaching electricity and hydrodynamics for the first time, and to those who have studied either alone in detail. S. C.

The Surveyor's Art.

Geodesy: Including Astronomical Observations, Gravity Measurements, and Method of Least Squares. By Prof. G. L. Hosmer. Pp. xi + 368. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 18*s.* 6*d.* net.

PROF. HOSMER'S text-books on surveying and allied subjects are well known, and any further contribution from his pen is sure of a welcome from all those either actually engaged upon, or interested in, the art of mapping the earth. We here use the word "mapping" in its complete sense—namely, as including everything requisite to the most minute delineation of the earth's surface, and of such physical quantities dependent upon its interior constitution as can be determined by surface observations.

The present book, based upon the practice and researches of the United States Coast and Geodetic Survey, is designed as a text-book for students of the higher branches of the art. We can only lament that no such volume has yet appeared based upon British surveying practice, a deficiency due partly to the fact that the great survey work of a geodetic character recently in progress in the British Empire has been that carried out by the Indian Survey Department, a body which has always trained its own staff and never summarised its methods in a text-book, and partly to the complete non-existence of any school of geodesy in this country. Should such a school ever be established, and should we ever recognise that, taking the lowest point of view, it would pay us to put the survey of our African territories upon a scientific and permanent basis, and to discontinue the present fragmentary, haphazard, and unscientific methods, the experience gained by the United States Coast and Geodetic Survey, the system it has evolved, and the body of practice it has formulated will be worthy of the closest study. On some points of detail surveyors trained in other countries would doubtless depart from the American practice, while the latter would, in other points, possibly require supplementing; there has been, for example, little occasion to develop any procedure specially applicable to very dense forest country; but on the whole the experience and skill of the American surveyors may be safely taken as guides for any future work.

We do not quite follow Prof. Hosmer in his apparent support of the now rather out-of-date search for the "figure of the earth" in the form of the spheroid which most closely fits the true surface. For convenience of calculation some spheroid must be assumed, but, provided that this is approximately true, such an approximation as is furnished by any of the well-known figures, the exact spheroid selected is unimportant. The shape of the geoid, the ultimate objective of the surveyor, can be as well represented in relation to one spheroid as to another. Great practical convenience, however, accrues if all survey systems—in any case those which have, or possibly could have in the future, a land connection—are reduced to the same conventional figure. All the North American surveys from Canada to Mexico have now adopted the Clarke (1866) figure and no further knowledge of the earth's true shape will compel them to abandon this as the basis for their reductions.

As regards the system of levels we are doubtful whether the convention adopted in the United States of applying an orthometric correction and thus defining level so that two points on an undisturbed lake are at different levels is, on the whole, the best. We should prefer to treat any points on the same equipotential surface as being at the same level, and re-define height to mean the distance of the equipotential from the geoid at a selected latitude. This is a subject which might with propriety engage the attention of the International Geodetic Congress when that body is summoned. E. H. H.

Ronald Poulton.

The Life of Ronald Poulton. By his Father, Edward Bagnall Poulton. Pp. xi + 410. (London: Sidgwick and Jackson, Ltd., 1919.) Price 16*s.* net.

NOT only those who were the intimate companions of Ronald Poulton, but likewise the rest—and they were legion—who admiringly witnessed his deeds of prowess in the field, were able to realise that behind all the brilliant qualities of

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